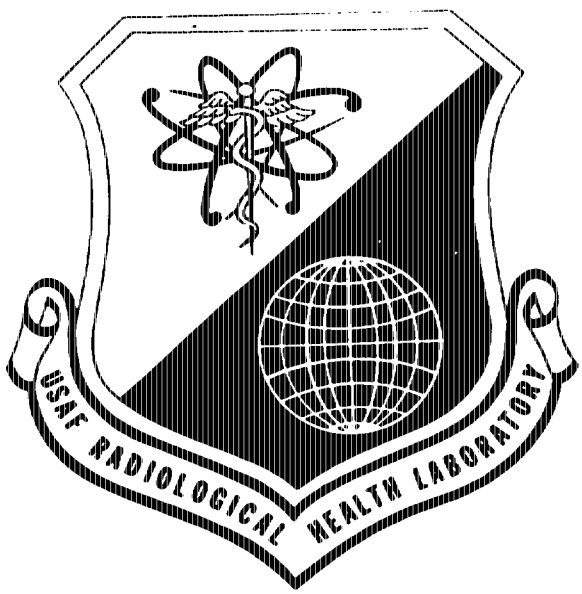
DEPARTMENT OF THE AIR FORCE
AIR FORCE LOGISTICS COMMAND
WRIGHT-PATTERSON AFB, OHIO

PLUTONIUM DEPOSITION REGISTRY BOARD

PROCEEDINGS
First Annual Meeting
26 - 28 October 1966



Prepared by:
L. T. Odland, LtCol, USAF, MC

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PROCEEDINGS

First Annual Meeting

PLUTONIUM DEPOSITION REGISTRY BOARD

PURPOSE: To review results of bio-assay data collected in support of Palomares Broken Arrow operation, and related matters.

PLACE: Room B-98, USAF Hospital Wright-Patterson, Air Force Logistics Command, Wright-Patterson AFB, Ohio.

TIME: 0830 hours.

DATE: 27 Oct 1966.

ATTENDEES:

Guest Speaker

BrigGen John M. Talbot, USAF, MC, Special Assistant to
The Surgeon General for Medical Research
Hq USAF, Wash DC

Registry Board Members

Col Louis B. Arnoldi, USAF, MC - Chairman
Command Surgeon, Hq AFLC
Wright-Patterson AFB Ohio

W. H. Langham, Ph.D.
Los Alamos Scientific Laboratory
Los Alamos NMex

W. D. Norwood, M. D.
Medical Director, Hanford Occupational Health Foundation
Richland Wash

Col J. A. Hennessen, USAF, MC
Commander, USAF Hospital Wright-Patterson
Wright-Patterson AFB Ohio

LtCol W. E. Froemming, USA, MC
Preventive Medicine Division, Office of The Surgeon General
Dept of the Army, Wash DC

Cmdr C. F. Tedford, MSC, USN
Office of the Director, Submarine & Radiation Medicine Div
Dept of the Navy, Wash DC
(for Capt J. Schulte, MC, USN)

LtCol L. T. Odland, USAF, MC
Commander, USAF Radiological Health Laboratory
Wright-Patterson AFB Ohio

Consultants

M. A. Quaife, M. D.
Chief, Special Laboratory of Nuclear Medicine & Biology
Veterans Administration Hospital, Omaha Nebr

LtCol D. R. Lindall, USAF, MC
Chief, Bionucleonics, Office of the Surgeon General
Hq USAF, Wash DC

LtCol K. T. Woodward, USA, MC
Director, Division of Nuclear Medicine
Walter Reed Army Institute of Research, Wash DC

Capt R. K. Skow, MSC, USN
Radiation Safety Officer
National Naval Medical Center, Bethesda Md

G. M. Dunning, Ph.D.
Deputy Director, Division of Operational Safety
Atomic Energy Commission, Germantown, Md

Mr. W. E. Sheehan
Health Physics Department
Mound Laboratory, Miamisburg Ohio

Maj J. McBain, USAF, MC
Department of Medicine, USAF Hosp
Wright-Patterson AFB Ohio

Capt J. Pizzuto, USAF, BSC
Office of the Director of Nuclear Safety
Inspector General's Office, Kirtland AFB NMex

W. B. Johnston, Ph.D.
Office of the Director of Nuclear Safety
Inspector General's Office, Kirtland AFB NMex

Speakers

BrigGen J. M. Talbot
Col L. B. Arnoldi
LtCol L. T. Odland
Maj J. C. Taschner
Capt J. Pizzuto
Capt R. G. Thomas
Lt H. R. Kaufman

Observers

LtCol R. E. Benson, USAF, VC
Deputy Commander
USAF Radl Health Lab, Wright-Patterson AFB Ohio

Capt G. S. Kush, USAF, BSC
OIC Film Dosimetry Section
USAF Radl Health Lab, Wright-Patterson AFB Ohio

Ltjg R. T. Bell, USN
Radiation Safety Officer
National Naval Medical Center, Bethesda Md

Mr. W. R. Wood, Jr.
Health Physics Department
Mound Laboratory, Miamisburg, Ohio

Dr. C. E. Newton
Battelle-Northwest
Pacific Northwest Laboratory, Richland Wash

W. E. Lotz, Ph.D.
Medical Branch, Division of Biology & Medicine
Hq USAEC, Wash DC

Capt R. G. Conrad, USAF, BSC
Chief, Special Activities Branch
USAF Radl Health Lab, Wright-Patterson AFB Ohio

FORMAL PRESENTATIONS:

Opening Address - Brig Gen J. M. Talbot, USAF, MC

On behalf of the Surgeon General and the United States Air Force Medical Service, I want to add my welcome to the participants in this first meeting of the USAF Plutonium Deposition Registry Board. The Air Force is particularly grateful to those of you from our sister military services, the Atomic Energy Commission, the Veterans Administration, and the civilian scientific community who have consented to serve as members or as consultants to this board.

The large number of observers at this meeting is also gratifying to us. It indicates the continuing interest in Plutonium-239 inhalation and internal deposition, and further reinforces our belief that establishing and maintaining this permanent registry and its associated board, are, indeed, essential. For those of you who are visiting Wright-Patterson Air Force Base for the first time, I would urge you to visit the USAF Radiological Health Laboratory, if your time permits. This laboratory is unique in being the only military laboratory within the free world exclusively devoted to handling all laboratory aspects of occupational radiological health. In addition, the Radioisotope Clinic here in the hospital, the Nuclear Engineering Test Facility reactor on the other side of the base, and the various component laboratories of the USAF Aerospace Medical Research Laboratories are also worth visiting. In terms of personnel, the Air Force has concentrated a pool of its finest talent in health physics, applied radiobiology, reactor technology, and nuclear medicine here at Wright-Patterson, in support of these various laboratories and their headquarters.

Little needs to be said about the more dramatic aspects of the Broken Arrow of last January 17. In the nine months which have elapsed since that tragic day, "Palomares" has become virtually a household word, at least, within the military. Television news coverage and special programs in the first three months following the accident were widely viewed. Reams of articles concerning this Broken Arrow have poured from the popular press, and as recently as last month The Reader's Digest magazine published an excellent 35-page special feature on this subject, in lieu of its usual best-seller condensation. A Broadway play on Palomares and the missing bomb is (or was) scheduled to go into production this coming winter. (Who, one wonders, will be cast in the role of Dr. Wright Langham?)

We, here today, are concerned with less dramatic but equally-significant sequelae to the Palomares Broken Arrow. Shortly after the accident it became evident that the plutonium contamination problem in Palomares was going to be far more extensive than initially supposed--and that, despite protective measures, a large number of military personnel involved in the clean-up operation were receiving or would receive, at least, a fraction of a body burden of Plutonium-239. Concerned individuals in the USAF Medical Service were aware that there was little information in the literature on which to predict medical disability or complications which may arise subsequent to the inhalation and deposition of Plutonium-239 in the lungs and other organ systems of man. They were further aware that many medical authorities are of the opinion that small amounts of Plutonium-239 detectable in the urine; i.e., amounts less than acceptable body burden, are of biological significance, since permissible burdens as assayed by urinalysis may only vaguely indicate the amount of the isotope which may be deposited in the lungs. They knew that the present acceptable body burden of Plutonium-239 is based on extrapolations from experience with radium-dial painters and small animals. Until the present, we have not had a group of human exposures of statistically-significant size which we could study, in an attempt to better define the medical hazards subsequent to inhalation of Plutonium-239, and such reports as do appear in the literature for the most part describe chronic occupational exposures. Since Plutonium-239 was not discovered until 25 years ago, no cases have been followed for longer periods of time. While it seemed highly unlikely that any individual involved in the clean-up operation in Palomares had, or would receive, sufficient internal deposition of Plutonium-239 to warrant consideration of clinical treatment, it was felt that the Air Force Medical Service could be in a precarious position were the question of treatment to arise following any future Broken Arrow. No physician in the Air Force has, to date, ever treated an individual for plutonium deposition. Further, although techniques of treatment are available, there is no unanimity of opinion, even in the civilian scientific community, as to when treatment should be initiated and as to the duration of treatment.

The medicolegal aspects involved in a large number of military personnel with internal deposition of Plutonium-239, even though at levels below one body burden, also concerned us. As most of you are well aware, instances of disease or injury due to alleged ionizing radiation exposures during prior military service are increasing in frequency. True, many such claims are absurd, but all of them require at least minimal investigation in order to forestall further unnecessary, time-consuming, and expensive action over non-valid claims. Some such claims are total frauds, perpetrated for individual publicity, financial

gain or other factors. As often as not, however, the claims are submitted by well-meaning individuals, who are grasping at straws to explain the origin of their disease. The latest such case in which my staff became involved concerned a schizophrenic beatnik in San Francisco, who was a sometime in-patient at a California State Mental Hospital. During his more lucid intervals, when he would be released on out-patient status, he proved to be an inveterate letter-writer, particularly after he decided that his schizophrenia had been induced by ionizing radiation exposure received during a 4-year tour of duty with the Air Force between 1954-1958. Where and when had he been exposed to this ionizing radiation? In his own words, he had flown over a portion of the State of Nevada en route from Oxnard Air Force Base, near Ventura, California, to a brief TDY at Nellis Air Force Base in Las Vegas, during Operation Plumbob. Review of his records revealed that he had no connection with weapons testing in Operation Plumbob or any other nuclear test. His service medical record was negative for everything except mumps and athlete's foot, both incurred while in service. I might add that this chap wrote letters to the Atomic Energy Commission, the Veterans Administration, and DASA, before settling on the Air Force as the agency responsible for his recent schizophrenia.

With all of the above factors in mind, a small group of USAF Medical Service officers concerned with nuclear weapon accidents met in Omaha, Nebraska, during a spring blizzard late last March, to review the medical aspects of the Palomares Broken Arrow. It was unanimously decided that the USAF Medical Service needed to develop a detailed and long-range program to provide adequate follow-up and treatment, when and if required, for military personnel with internal plutonium deposition resulting from the Palomares Broken Arrow, as well as from any future weapons or laboratory accidents involving internal deposition of plutonium. The concept of a Plutonium Deposition Registry and Registry Board was felt to be the best approach to conducting this program. The program would have three primary purposes:

(1) It would provide adequate follow-up of personnel with internal deposition of plutonium, in order that any possible biological injury would be detected at the earliest possible date, and it would provide, when required, the best possible treatment to reduce body burdens of Plutonium-239.

(2) It would provide the government with complete factual data upon which to evaluate claims for compensation which might subsequently arise.

(3) It would provide the medical profession with additional urgently-needed data with which to manage medical problems resulting in future Broken Arrow or laboratory accidents of a similar nature.

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Since that meeting in Omaha last March, the Plutonium Deposition Registry and Board have become a reality. As originally conceived, the Board was to be tri-service in nature, with non-voting liaison members from the Atomic Energy Commission, the Veterans Administration, and Defense Atomic Support Agency. However, to expedite establishment of the Registry and the Registry Board, they were created within the Air Force, and the selection of the USAF Radiological Health Laboratory as the permanent location for the Registry was, of course, an obvious choice since almost all of the plutonium bio-assays following the Palomares Broken Arrow were performed here. Further, the USAF Hospital Wright-Patterson is the single USAF Hospital designated as a specialty center in the treatment of occupational disease. Finally, we have a unique, and, for the purposes of this Registry and its Board, a highly-desirable management situation in the Office of the Surgeon, Air Force Logistics Command here at Wright-Patterson Air Force Base, to which both the USAF Radiological Health Laboratory and this hospital report directly. Colonel Arnoldi and his highly-competent staff are deeply involved and personally interested in all aspects of occupational medicine. Thanks to their cooperation and administrative support, establishment of this Registry and its Board entailed no financial complications whatsoever.

The function of this Registry is, of course, to maintain permanent records of Plutonium-239 bio-assay and other pertinent laboratory and medical data on all military personnel who have received or who will receive internal deposition of Plutonium-239 above such limit as may be established by the Registry Board. Because it was essential to establish some limit within which the USAF Radiological Health Laboratory might operate in the months prior to formal establishment of this Registry and the initial meeting of the Board, the Air Force Medical Service unilaterally selected a cut-off of 9% of one body burden of Plutonium-239 as the level above which personnel would be included in this Registry. This figure is not irrevocably fixed, and it may be raised or lowered at the discretion of the Registry Board. The Registry will have to maintain permanent contact with individuals included in the Registry, and will, at the request of the Board, schedule and perform follow-up laboratory procedures on these individuals. The administrative problems involved in such permanent follow-up are self-evident in view of the increasing mobility of the civilian population in the United States. In the past few

months the mobility of military personnel has also proven to be a large problem for the Board. Many of the personnel who received internal deposition of Plutonium-239 in the Palomares clean-up operation have already completed military tours and returned to civilian life. Further, because of the emergency nature of the clean-up operation, large numbers of military personnel were sent to provide assistance in Palomares on emergency temporary duty orders, some of which did not become formalized on paper until a later date. This has entailed administrative problems for the Registry in establishing with certainty the home base of certain personnel on whom urine specimens were forwarded to the laboratory for bio-assay. The current military action in Southeast Asia, the current military withdrawal from France, and the recent withdrawal of the Air Force's Strategic Air Command from Spain, have increased the numbers of personnel transfers, and have further compounded the problem of follow-up of personnel involved in the Palomares Broken Arrow. Thus, long-term follow-up of large numbers of personnel cannot be assumed to be an easy task.

The Registry Board will be responsible for determining who shall be included in the Registry, and what shall be the nature of routine long-term follow-up. The Board will determine when treatment for Plutonium-239 internal deposition is required, will determine the type of treatment indicated, and will supervise treatment, as required. In the event that an individual on the Registry develops a pathologic process related or potentially related to Plutonium-239 internal deposition, the Board will, insofar as possible, insure that complete postmortem studies are performed, the exact nature of these studies to be determined by the Board in cooperation with the Radiation Pathology Register of the Armed Forces Institute of Pathology.

This Board will be required to make some difficult and far-reaching decisions. Fortunately, for the three military services, the Board includes two of the world's most knowledgable scientists in the area of internal deposition of plutonium--Dr. Langham and Dr. Norwood. I want to extend special appreciation to these two gentlemen for consenting to serve on the Board, in view of their already heavy schedules in their own laboratories and elsewhere in the scientific community. I hope that the data available to them through this Registry will prove of value in the programs and studies underway in their own laboratories. Since this Registry and Board are envisioned as completely "non-partisan", we welcome participation by, and free exchange of, information with all interested governmental and quasigovernmental agencies.

Wright-Patterson AFB as a Nuclear Center

Col L. B. Arnoldi, USAF, MC

Col Arnoldi urged the Board and consultants to consider adopting a common format for the recording of radiation exposure (internal and external) data, and that a central repository be set up to maintain this information and retrieve it as desired. Within limits imposed by operating policies, Col Arnoldi placed at the disposal of the Board, the computer and ancillary facilities of Hq Air Force Logistics Command for whatever use they might suggest. Because of the unique resources in the nuclear energy field available at Wright-Patterson AFB, he urged that this base be considered as a nuclear medicine research and operational center.

The USAF Hospital, Wright-Patterson, the Nuclear Engineering Test Facility, and the USAF Radiological Health Laboratory were singled out as the keystones upon which such a center could be built.

Capt J. S. Pizzuto, USAF, BSC

On 17 Jan 66 a B-52 bomber and KC-135 tanker aircraft collided in flight over or near Spanish territory. The resulting impact permitted the uncontrolled dispersion of four nuclear weapons, three of which fell on Spanish soil and one in the Mediterranean Sea.

Immediate search operations located the three devices on the ground and verified that the integrity of two was destroyed. High winds permitted dispersal of 239-plutonium over a wide area.

Because the whereabouts of the fourth weapon remained a matter for speculation, a large-scale search operation continued on land and sea until 26 Mar 66, when it was removed from the sea. Nearly 2000 American personnel participated in the search, and many Spanish Nationals were also involved. During this period the 239-plutonium constituted an inhalation hazard, even though precautions were taken to prevent gross exposure.

Before completion of the task, several tons of topsoil were collected, sealed in barrels, and removed to a national nuclear burial ground in the United States.

Sample Control System

1Lt Harold R. Kaufman, USAF

The sample control system permitted the laboratory to keep accurate records on all samples received for analysis. In addition, it provided a simple, fast, method of recalling data for report generation and statistical analysis.

The combined resources of the punch-card equipment and the Mathatron desk calculator located in the laboratory, and the IBM 7094 DCS located at Aeronautical Systems Division, gives this laboratory a formidable data-processing capability that should be able to meet any requirement placed on it by the Plutonium Deposition Registry Board.

Analytical Chemistry Methods Used in Processing Samples

Maj J. C. Taschner, USAF, BSC

Initial urine samples from personnel involved in the Palomares search and recovery operation were processed, using a gross alpha screening procedure. The steps in this procedure were:

(1) wet ashing of an aliquot of the urine sample with concentrated nitric acid and hydrogen-peroxide to a white ash;

(2) Solubilizing the white ash and coprecipitation of plutonium with bismuth salts;

(3) dissolution with hydrochloric acid followed by the addition of lanthanum carrier before hydrofluoric acid precipitation;

(4) direct mounting of the precipitate on a 2" steel planchet; and,

(5) counting for 120 minutes in an internal proportional counter.

Plutonium-239 spiked pooled urine samples were processed in a like manner to obtain quality control data. Plutonium recoveries of 75.6 ± 19.6 percent (68% confidence) were obtained.

Because of field contamination of initial samples, a resampling program was initiated 2-3 months after the personnel returned to their home base. A procedure which is specific for plutonium was adopted for the resample urines. One-half of the total urine sample was adjusted to pH 2 with concentrated nitric acid. A plutonium-236 internal tracer was added to each sample for quality control. The sample was then heated to boiling to break any metabolic complex-binding plutonium. The plutonium was coprecipitated with the alkaline earth phosphates by adjusting the urine sample to pH 10 with concentrated ammonium-hydroxide. The salts were dissolved in nitric acid and coprecipitated with radio-chemically-pure cerium by adjusting to pH 4.5. This precipitate was dissolved in hydrochloric acid and passed through an anion-exchange column which adsorbs the plutonium. Interfering anions adsorbed on the column were removed by washing with hydrochloric acid. Hydriodic acid was used to elute the plutonium from the ion-exchange column. The plutonium was changed to the sulfate salt by heating the evaporated column

residue in sulfuric acid. The solution was adjusted to approximately pH 3 and electroplated on a one-half inch steel planchet. A solid state alpha spectrometer was used to measure the plutonium alpha activity present. Plutonium recoveries of 75.6 ± 16.2 percent (68% confidence) were obtained.

Counting Procedures for 239-Plutonium in Urine

Capt R. G. Thomas, USAF, BSC

I. Counting procedures used for initial samples:

Samples were counted, using Nuclear Measurement Corporation PC-3A, windowless, gas-flow proportional counters. Daily checks were made on instrument performance by counting reference standards of 239-Pu, to insure constancy of counting efficiency. Samples were counted for 120 minutes and backgrounds were counted daily, normally for 960 minutes. The daily background counts also served as checks on contamination; the counting chambers were decontaminated when background became greater than 0.1 count per minute. Normal backgrounds ranged from 0.02-0.06 count per minute.

Sample activity was calculated from the following expression:

$$\text{pCi/sample} = \frac{(\text{gross counts/gross ctg time}) - (\text{bkg counts/bkg ctg time})}{(\text{counting efficiency})(2.22)\,(\text{procedural yield})}$$

II. Counting procedures used for resamples:

The detectors were solid-state surface-barrier types mounted in a vacuum chamber. Charge sensitive preamplifiers, designed and built by Mr. Robert L. Farr of the laboratory staff, were used to amplify signals from the detector. Output from the preamplifiers was fed to a Nuclear Data 130 AT multichannel analyzer. Readout from the analyzer was in the form of typewriter printout.

Using an electroplated source containing known activities of 239-Pu and 236-Pu, instrument performance was checked each morning before beginning counting, and normally, an additional time each afternoon. The performance check consisted of observing the peak channels for 239-Pu and 236-Pu, and adjusting the gain of the amplifier system, if necessary, to correct for any gain shifts. Additionally, the counting efficiency of the system was checked at the same time, to insure constancy.

Background counts were made each night for 800 minutes' duration, with a blank planchet in the counting chamber. The daily background count also served as a check for any possible contamination in the

counting chamber. Samples were routinely counted for 100 minutes.

The data was collected in an analyzer memory of 255 storage positions. Total counts in two bands, centered on the peak channels of 239-Pu and 236-Pu, and each containing 11 storage locations, were totaled and used for the sample activity calculations. The same bands were used for both sample and background determinations. Sample activity was calculated from the following expression:

$$\text{pCi/sample} = \frac{(\text{net cpm in 239-Pu band}) \times (\text{dpm 236-Pu added})}{(\text{net cpm in 236-Pu band} \times (2.22)}$$

$$\text{where net cpm in 239-Pu band} = \left[\frac{\text{gross cts 239-Pu band}}{\text{gross ctg time}} - \frac{\text{bkg cts in 239-Pu band}}{\text{bkg ctg time}} \right]$$

$$\text{net cpm in 236-Pu band} = \left[\frac{\text{gross cts 236-Pu band}}{\text{gross ctg time}} - \frac{\text{bkg cts 236-Pu band}}{\text{bkg ctg time}} \right]$$

dpm 236-Pu added = activity of 236-Pu spike added to sample corrected for decay to date of count.

RESULTS

Initial Urine Samples--Alpha Activity

LtCol L. T. Odland, USAF, MC

	Air Force	Army	Navy	Other	Total
Number analyzed	1389	107	37	38	1571
BB* greater 100%**	19(0)	1(0)	0	0	20
BB 0.99 to 0.09	361	33	5	8	407
BB 0.09 to 0.009	487	23	20	7	537
BB less than 0.009	522	50	12	23	607

* Systemic body burden (bone, critical organ)--calculated on the basis of urinary excretion according to expression

$$D = 435\ U\ t^{0.76}$$

where D = systemic body burden

U = 239-Pu activity in 24-hour sample

t = time in days from exposure to sampling

** Value of 0.044 μCi 239-Pu for D represents one body burden or 100%.

RESULTS

Miscellaneous Samples

LtCol L. T. Odland, USAF, MC

WATER

Samples analyzed	40
No detectable activity	7
Range of 0.1 to 633 pCi/liter	33
Median value of 1.64 pCi/liter	

VEGETATION SWIPES

Total swipes counted	78
No detectable activity	63
Range of 0.1 to 4.3 pCi	13

NASAL SWIPES

Total swipes counted	120
No detectable activity	70
Range of 1.0 to 337 dpm	50
Mean 24.4, S.D. 48.0, median 13 dpm	

SOIL

Total samples -- gamma scan 23

Peaks at 60, 27, 16, 110, 185 Kev

VEGETATION

Samples too active for processing

RESULTS

Resampling Program
(As of 1 Nov 1966)

LtCol L. T. Odland, USAF, MC

	Air Force	Army	Navy	Other	Total
BB* greater 10%	6	0	0	0	6
BB 1 to 10%	162	10	5	0	177
BB less 1%	36	11	1	1	49
BB zero	124	9	2	6	141
Number requested	328 (363)	30 (33)	8 (5)	7 (8)	373 (409)

*BB defined as systemic body burden (bone, critical organ).

Analysis of BB Greater 1% Group

(183 Samples)

	Mean	SD	Median	Range
239-Pu (curies x 10^{-15})	93	63	77	26-390
236-Pu spike (% recovery)	76	13	75	43-109
Sample volume (liters)	1.3	0.5	1.2	.29-3.1
Elapsed time (days)	147	25	140	110-237
BB (%)	4	3	3	1-16

SUMMARY OF DISCUSSIONS:

Use of the term "body burden." Dr. Norwood expressed objection to the use of the term "body burden" in presenting results. He stated the term is misleading since it could be interpreted to include the entire body when, in reality, it refers only to that portion of 239-Pu distributed by systemic circulation, and, in no way, reflects that which may be fixed in thoracic viscera. Dr. Norwood further stated that correction values have been suggested to permit estimating lung burden from system burden. Depending on various factors, a correction of 10-100 could be applied to systemic burden to estimate lung burden.

Dr. Langham stated that the formula he developed for use in estimating body burden was never intended to apply to lung burdens. He related some of the history of his early work and that of colleagues on this problem, and questioned the whole concept of critical organ in relation to inhalation exposures of 239-Pu. Systemically, the bone is considered the critical organ, while in the chest it may be lung or lymph nodes, or both, but in the case of inhalation exposures, the thoracic viscera may be the important tissue with bone receiving only an insignificant dose. In summary, Dr. Langham stated that he did not like the application of corrective factors to body burden to estimate lung burdens, particularly when the corrective factor varies by at least a factor of 10, and the basis upon which this value is derived is somewhat nebulous. Dr. Norwood agreed that it was difficult to assign a corrective factor to body burden in order to arrive at the lung burden. Several other attendees voiced their feelings on this problem, and the consensus was that lung burdens, under conditions of uncontrolled acute inhalation exposures, are impossible to accurately measure at this time.

In an effort to more accurately present analytical results, the term body burden will be modified to reflect its reference to systemic with bone as the critical organ, and, in addition, absolute terms of activity per sample will also be reported along with sample volume, elapsed time, etc.

Reporting of Results. The question was raised whether or not the individual results should be reported back to appropriate units of assignment and entered in medical records. One objection to reporting results was that they may be misinterpreted at the local level, and perhaps set the stage for legal action. Dr. Norwood felt the results should be reported

because the doctors involved must be given this information. LtCol Froemming stated that the Army wanted something entered in the medical records, but was not firm on just what form the entry should take. Cmdr Tedford stated the Navy did not want their results entered in medical records, and that the USAF Radiological Health Laboratory should maintain these records as a part of a repository from which the data could readily be retrieved when desired. General Talbot stated that the question, insofar as the Air Force was concerned, should be studied by legal advisors prior to a decision.

It was decided that the USAF Radiological Health Laboratory would send results of bio-assay work to the appropriate Surgeon General for deposition and recording, as he saw fit. Dr. Johnston pointed out that exposures or body burdens of 239-Pu do not have to be given to the individual concerned since this material does not come under the provisions of 10CFR.

GENERAL DISCUSSION:

Item Nr 1 -- Should continued efforts be made to secure initial and/or repeat samples on all personnel who have not been tested but who were in the area?

The board recommended that continued efforts should be made to secure initial samples from individuals who participated in the operation and departed the area without submitting a specimen. In addition, it recommended that continued effort be made to secure a second sample from individuals whose initial sample contained sufficient activity to suggest a systemic body burden in excess of 9%, and who failed to respond to the resampling program. The maximum extent of this effort should consist of two letters soliciting cooperation, and one telephone call. Accurate records will be kept of the communications, since the primary reason for the continued effort is to demonstrate a reasonable effort to screen every individual involved. The board felt that it was extremely unlikely that any individual would display excretion values at significant variance from those obtained to date.

Item Nr 2 -- Does the board recommend resampling of individuals whose initial urine samples showed less than 9% of one body burden?

The board recommended that no further effort be devoted to resampling individuals whose initial urine sample showed activity suggesting a systemic body burden less than 9%.

Item Nr 3 -- At what level of body burden, if any, obtained on resampling does the board recommend continued follow-up? What should be the nature and frequency of such follow-up, if recommended?

Dr. Langham pointed out that the results of the bio-assay program were very good in terms of preventive medicine and risks to individual patients, but insofar as providing a basis for follow-up and long-term study, they provided little reason for enthusiasm. Dr. Norwood concurred in this observation, as did other attendees, all agreeing that the bio-assay data showed levels of activity far below those necessary for a meaningful follow-on program to assess excretion patterns, use of whole-body counting techniques, etc. Capt Skow stated that no follow-up effort should be devoted to any individual whose systemic body burden was less than 50%. Dr. Norwood suggested continued bio-assay studies on all individuals whose systemic body burden was 9% or greater. After more discussion on this point, it was agreed that continued follow-up bio-assay studies at a frequency of once every two months would be done on the highest 10% of the resampling group that showed a systemic body burden of between 1-10%. This number would be about 17, and would include some with systemic body burdens as low as 7%. Considerable discussion centered around the possibility of inciting undue concern in these individuals, perhaps to the point of legal action for compensation. However, this was realized, and a certain probability of risk had to be accepted if any follow-up program was to be pursued. All attendees agreed that whole-body counting techniques are not sufficiently refined to be utilized in any follow-up program on this group, and, certainly, there was no indication for treatment.

Item Nr 4 -- Should whole-body counting techniques be developed by the U. S. Air Force for detection of 239-Pu-241-Am as an additional tool, in the event of future similar incidents? If affirmative, what type of hardware is recommended?

This subject stimulated a lengthy and detailed discussion on the whole problem of in vivo assay of 239-Pu-241-Am using whole-body counting techniques. Dr. Norwood and Mr. Newton discussed the advances that have been made on the problem, and felt that it was just a matter of months before the hardware would be perfected. Dr. Langham related the experience of his group and others in building a device suitable for detection of 239-Pu in vivo and the application of it to the Spanish incident. He further related that detection can be done, but the problem of quantitating what is detected is still formidable. Apparently, levels on the order of nanocuries in the thorax can be detected, either by counting 239-Pu or via extrapolation of 241-Am content. It became obvious, as the discussions continued, that whole-body counting was possible, but that no one is willing to categorically state their limits of detectability, or advertise as being operational and ready to accept candidates. Dr. Dunning expressed a personal opinion that the USAF Radiological Health Laboratory should develop a capability in this area if it is to be more adequately prepared for the next Broken Arrow. Dr. Langham and Mr. Newton advised caution on development of whole-body counting techniques by the USAF because of the developmental effort going forth in other quarters. However, Dr. Langham felt such experience would be valuable for the USAF in that it would place it in a much more ready position for future incidents, but certainly could be of no value in this (Palomares) incident.

LtCol Woodward asked where assistance would be available in the event the Army experienced a Broken Arrow of significant proportions. Specifically, he wanted to know what one group had facilities for whole-body counting, treatment and bio-assay. Dr. Norwood stated his group had capability to handle a small (5-8) number of patients, could do bio-assay tests in large numbers, and would soon have whole-body counting facilities. Col Hennessen stated his hospital census was running over 90%, but he could handle perhaps up to 20 patients at any given time.

No specific recommendations were obtained with respect to the type of hardware that should be used.

Item Nr 5 -- By using ratios of 239-Pu to 241-Am in the weapon, soil, and urine, is it possible to determine the 239-Pu content of the lungs using 241-Am values determined by whole-body counting techniques?

Mr. Newton reviewed data on recent studies of 241-Am and 239-Pu in laboratory animals following inhalation exposures which indicated that americium may move out of the lungs faster than 239-Pu under certain experimental conditions. In these studies the ratio of 239-Pu to 241-Am varied by a factor of 2 from what it was in the inhaled material.

Messrs Sheehan and Wood presented bio-assay (urine) excretion data on five individuals who have appreciable systemic body burdens of 238-Pu as a result of inhalation exposures. The information suggested that at about 150 days after an acute exposure the urinary excretion values parallel quite closely with those predicted by a computer model, and that both follow Langham's equation quite well, subsequent to this time period.

While certainly not applicable to exposures under consideration, it was conceded that if future Broken Arrow incidents resulted in inhalation and retention of nanocuries or more of 239-Pu and the attendant 241-Am, using the ratio of the two in the weapon, and determining a similar relationship in soil and urine, estimates based on whole-body assay of 241-Am by in vivo counting would give an estimate of thoracic burden no farther removed from reality than other methods or extrapolations currently available.